When disaster strikes with Igor Linkov

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Intro [00:00:05] Welcome to OECD Podcasts, where policy meets people.

Clara Young [00:00:10] Critical infrastructure like telecommunications, water and financial systems are complex, interconnected networks with many, many moving parts. What happens when there's a long heat wave or a cyber-attack? What about when a hurricane hits a coastal city like Miami? How ready is it for flooding, disrupted transport, electrical failure, contaminated water? Are its systems backed up? Has the city planned its roads and housing with an eye to sea level rise? And when disaster hits, how fast can a city get back on its feet? I'm Clara Young and I'm speaking today with Igor Linkov, who is the Risk and Decision Science Focus Area lead at the U.S. Army Engineer Research and Development Centre. He's also an adjunct Professor of Engineering and Public Policy at Carnegie Mellon University. So thanks for coming to talk to us, Igor.

Igor Linkov [00:01:01] My pleasure.

Clara Young [00:01:03] In 2003, some trees brushed against a high voltage power line in northern Ohio, and this caused a system shutdown there. The knock-on effects were this; a massive blackout in parts of Canada and eight U.S. states, including New York City, that eventually cost six billion U.S. dollars. Igor, can you talk us through the domino effect of what happened and what we learnt from this?

Igor Linkov [00:01:31] Yes, that blackout for me is a case where interconnected infrastructure react to something that is really minor. In response of these trees, it was a minor software glitch that cascaded in interruption and 55 million people were without electricity for a long period of time. So the mechanisms of this cascading failure in the system are not really well understood. And if you think about that, you're talking about just wires. It's a fully engineered system. We should know everything about design and what is going to happen with this, but nevertheless, we were unable to prevent this cascading failure and massive impact on the society.

Clara Young [00:02:15] What can we do about it? Are we any better since 2003 at managing these interconnected systems?

Igor Linkov [00:02:20] We are just beginning to realise that hardening of interconnected systems is not going to help, because hardening one component may not prevent failures in another component and critical function will still be paralysed.

Clara Young [00:02:30] What do you mean by hardening?

Igor Linkov [00:02:32] Investment in something like, you know, buying instead of one generator, two generators you had in one piece of the system, and you are not looking in other components. For example, if you have electricity but no water, it's not going to let you live for long, right? Well, if you have water, but no way to pump it out of the ground without electricity, this is interconnected infrastructure. It’s really important and we need to understand connections of that.

Clara Young [00:03:13] So, if just simply hardening infrastructure is not good enough, then what are we looking at now?

Igor Linkov [00:03:19] We need to understand how the system works or at least how we can manage the system in a way that we can recover from inevitable disruptions. Disruptions are inevitable just because it's the nature of modern time. We develop infrastructure to be efficient and we are reliant on computers. We are relying on many small things that may fail at some point, and then what happens after that needs to be mitigated. And we need to think not only about how to build efficient and functional systems, but also how you recover from disruption.

Clara Young [00:04:00] You know, going back to this 2003 episode, one of the things that governments and systems operators hadn't thought about was the connection between the fuel system and electricity. For example, people couldn't get gas for the cars because electricity couldn't pump it. Do we have an inventory now or analysis of interconnected systems? And how do we prepare for that?

Igor Linkov [00:04:25] We're beginning to think about that. If you think about the core of the problem, it's natural for engineers to design systems that are going to work no matter what happens, right? And that's how engineering as a field operates. But failure is inevitable, so we need to start thinking how we are going to recover the system from disruption, and this is really new science. It's a kind of blend of traditional engineering and system science that it's now just beginning to be developed, and we are here in NAEC and OECD, and this organisation is in the forefront of building new science or integrating science to build what is called resilience in system design.

Clara Young [00:05:15] What are, you know, just a wider note to our discussion right now, what are the biggest threats to critical infrastructure now that we face?

Igor Linkov [00:05:26] It's difficult to say. I believe, and again, I represent only my view, not views of U.S. government in this interview, in answering this question in particular, I believe that we are stuck to rely more and more on what is called smart systems. It's basically systems that are controlled by centralised computing power. And those systems may be affected by different software, hardware malfunction or adversarial attempts to interfere. So I think this is cyber-threats, probably the highest now in, you know, most of the civilian applications.

Clara Young [00:06:05] And I think that also with the Internet of Things and, and, you know, like the smart infrastructure that you were talking about, this is even this is going to complicate things even more.

Igor Linkov [00:06:17] Absolutely, yeah. Industry 4.0, our attempt to really make a digital revolution is really we should go that way, but we need to think about not only making the system more efficient, but also more resilient.

Clara Young [00:06:35] You have said in previous talks that our critical services have been designed for maximum efficiency, but that doesn't mean they're designed for maximum resiliency, and sometimes the

two can be in conflict, so what do you mean by that, and what's a good example of the two being going in opposite directions?

Igor Linkov [00:06:54] Yeah, so basically we have limited financial resources, and for example, you may invest a lot of these financial resources in making efficient production. So a good example are car manufacturers in Japan. They were really efficient, very lean supply chain, one very efficient supplier for one part. But then when Fukushima happened, many of the suppliers were not able to deliver, and what happened to car manufacturers was that they were basically stuck without any ability to quickly change suppliers. So then one of the small suppliers for minor components of the car resulted in an inability for Toyotas and Hondas of the world to really deliver complete vehicles. So why? Because it was very lean supply chain, it was efficient, under normal operation, it was perfectly fine. But when disruption happened, there were no plans to have another supplier or quickly figure out how to deal with that and that was really a miscalculation, and we keep doing that in many other systems. Again, resilience costs money as well, right? It's trading off efficiency versus resilience. To have two suppliers for the same thing instead of one costs more money, but it's absolutely crucial to think about how to make supply chain in the case of car manufacturing not only efficient, but also resilient and what should be the trade-offs.

Clara Young [00:08:33] Right. I mean, it's interesting that you bring up the point about, you know, it costs more money to make a system more resilient. I mean, who is going to pay for that? Do the private operators or the companies, will they pay more to make their systems more reliable, resilient, or where do governments come in that?

Igor Linkov [00:08:43] Again, talking as myself, I do believe we can make a business case for investment and resilience at the level of governments, and this is where OECD may be very instrumental, or even at the level of industry. Business continuity is really important. If you look at losses of the insurance industry, now half of it goes for business continuity, so when something happens, a company cannot continue. While only 20 years ago, most of the money lost by the insurance industry was property damage. So when the hurricane hit, you know, you lost your building - that's where the money came in. Now your computer is flooded and you cannot work. There, well, I'm simplifying, of course. So I really believe that even at the level of individual business, a value chain for specific product, there is an important role for resilience, and actually Resilience Shift funded by Lloyd's and Arup is really doing good work and thinking about the business side of resilience. But that's in private side, and in governments, OECD and many agencies in the US start to seriously think about how to deal with resilience.

Clara Young [00:10:05] One way to also take resilience more into account in urban planning and designing and maintenance is to turn away from just thinking about risk, because we talk a lot about risk - risk assessment, risk management - but it's different from resilience. So what is the difference? I mean, if you talk about risk-proofing a transportation system or energy grid, what's the difference between that and making it resilient?

Igor Linkov [00:10:32] When you think about risk, if you look at the Oxford Dictionary, risk basically starts with a fully functional system and we try to minimise threat or decrease vulnerability of the system to prevent it from going down. So if you do right risk management, the system will operate no matter what. That's a really laudable goal, if you can do that - it's really great. But unfortunately, there will be disruption, that system will fail, critical function, the system executed will go down. And at that point, resilience kicks

in. Resilience, defined by Oxford Dictionary, is the ability to recover from disruption, so the starting point for resilience is a disrupted system. Well, the starting point for risk is a functional system. Of course, if you think about what we like to get out of the system, we like it to function, but if it fails, we like to recover fast. And given the complex reality of modern infrastructure, you cannot really prevent bad things from happening. They will happen, and thinking about both the risk and resilience is of crucial importance.

Clara Young [00:11:40] If we take a concrete example - and when I say the word 'concrete' is probably literal - New York, Staten Island is designing a seawall along its coast to protect against rising sea levels. Now, if you could talk about, you know, AC (Army Corps) not only just this, what's the difference between a seawall that's designed to be first and foremost risk-proof and one that's designed to be both risk-proof and resilient? How is the process different?

Igor Linkov [00:12:05] Yeah, again, talking as an individual, not the Army Corps of Engineers, that probably will build this wall eventually, if you think about risk management, you will try to build the highest possible seawall, given the amount of money you have. You invest. You buy down as much risk as possible, and in the case of simple flood - again, simplifying - you build as tall a seawall as you can. If you think about a resilient seawall, you may not invest all your money in going up. You can go up to a significant degree, but then you start to think, OK, what if water over-topped? What's going to happen? And this is where resilience starts. The resilient seawall may be designed in a modular way that you have areas that are designed to fail and can be flooded, but then quickly recovered, quickly rebuilt.

Clara Young [00:12:59] How would you do that?

Igor Linkov [00:13:02] It's like, you know, you can have different modular structure seawall, like, for example, if you expect climate change, you can rebuild on top of what you have now. It's, of course, more complicated engineering design because you cannot really start rebuilding from most of the simple designs. You need to allow some features that allow it to get higher. So it's extra cost. So maybe if you have the same amount of money, you will not be able to go as high as you could with a simple design, but you may stop a little bit shorter, but invest in this resilience feature. Maybe you dedicate some area for controlled flooding, and that actually that's what was done in the past. Maybe you have like a more sophisticated design of seawall that will fail, but can be quickly rebuilt rather than getting rebuilt from scratch if you have the simplest one. So those are possible general type of considerations you have in mind.

Clara Young [00:13:57] There's also in a resilience approach, you would want to know what the community wants or what they find is most important to protect or to bounce back from, too. Isn't that the case?

Igor Linkov [00:14:16] Absolutely. Again, you can think about the situation - in one you have like a residential community on the shoreline and another, you have sophisticated lab testing equipment, right? And you try to build flood protection infrastructure. Of course, you don't like to build seawall in front of communities enjoying a view of the ocean, right? You know you can train them. So if there is a flood, you know, they know how to deal with that. They can elevate houses, they can, you know, have supply of food, they can evacuate. You can train community to respond to that. Well, if you have unique equipment, you, by all means need to build better protection, because you may lose a lot of value. So depending on the

critical function of the system, you may decide, even though you have the same amount of risk of incoming floods, you may decide on completely different mitigation policies, and it's all driven by community needs.

Clara Young [00:15:16] Right, so maybe not just a wall, to put resources into other things, like training people.

Igor Linkov [00:15:27] Absolutely.

Clara Young [00:15:29] OK, you know, let's turn to I think, for my last question, the whole globalization, and it's such that when critical infrastructures hit in one country is likely to impact other countries because we share as you gave your example with Toyota, we share supply chains, goods, services and information move back and forth between countries on the Internet. How good are governments at working together on these threat and disaster issues?

Igor Linkov [00:15:51] I hope OECD can help to make governments work together better. I was recently engaged in a meeting at U.S. Aid on Global Health, and it's really interesting to see discussions because, you know, ebolas of the world, they don't know political borders, right? So you can have a country well prepared for disease epidemics, but if it's coming from just neighbouring countries, maybe it's a completely different story. So this global impact of global threats, interconnected countries with infrastructure and people travelling, connecting and communicating - we are not prepared for that.

Clara Young [00:16:33] OK, well, thank you very much for speaking to us, Igor.

Igor Linkov [00:16:36] Thank you very much - it's my pleasure.

Clara Young [00:16:40]And thanks for listening to OECD Podcasts - I'm Claire Young. To find out more about what we've been talking about, read the OECD's 'Good Governance for Critical Infrastructure Resilience'.

Outro [00:16:53] To listen to other OECD podcasts, find us on iTunes, Spotify, Google podcast and SoundCloud.com/OECD.